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GENERAL REVIEWS AND SUMMARIES

SENSATION (GENERAL)

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Külpe's *Grundriss* (1893) may fairly be said to have done more than any other single book for the empirical derivation of the mental complexes from the elementary processes. His sections upon Centrally Excited Sensations and Connections of Conscious Elements are classical. Watt (**7**) now proposes, in the spirit of Külpe, to carry still further this empirical derivation. His method of "modalism" is, perhaps, less novel than the name implies. It consists in making diligent search among the sensations and their modes of integration for the grounds of mental experience. The point which Watt especially emphasizes is that causal explanation, rendered in terms of consciousness itself, may go much further than it has already gone by exploiting the attributive characteristics of the simple processes. He attempts, for example, to reduce feeling and recognition to modes of integration, and he suggests that the analysis of the thought processes themselves may, in time, be carried through by the same sort of reference. The article is an effective counterblast to the doctrine of formal elements; although it does not indicate a wide acquaintance with the literature of the *Gestaltqualität*. As regards perceptual, and certain other, complexes, Pillsbury (**4**) looks upon the given sensory materials as inadequate either for description or for explanation. Neither sensation nor movement offers a true account of perception. "Mental life," so he says, "is everywhere concerned not with immediate sensation or image but with things, with real events, and ideas. These things or ideas or concepts are not composed of sensations, but they are results of working hypotheses that

have sprung up spontaneously and have been confirmed by experiences, or have been modified with experience, until they have taken on a form that is adequate to experience." "Things are types, space and time are types, relations are types. All the products of perception that have any meaning are types, are the products of much organized experience brought to bear upon the momentary stimulus, rather than the immediate effect of that stimulus upon the organism." However helpful the concept of the "type" may be to the understanding of the "thing" perceived, it can hardly be expected to take the place of such minute empirical descriptions of perceptual complexes as are to be found, say, in Linke's stroboscopic assimilations, or Krüger's consonances, or Stumpf's fusions.

Paulsen (3) attacks the psychophysical basis of Ziehen's *Erkenntnistheorie*. Sensations regarded as "contents" are already "objective," and they do not therefore form a suitable psychological foundation upon which the cognitive functions are to be developed. Ziehen's idea (*Vorstellung*) suffers from the same kind of error when considered as a psychological datum: it differs from sensation not in its positive character but in its lack of vividness or, at most, in its independence from stimulus. Stimulus itself Ziehen uses without warrant, for it takes him behind the datum of experience, *i. e.*, sensation, to an object which is already the product of cognition. Paulsen would regard consciousness not as contents, not as "ein Schauplatz, auf dem willkürlich zugefällig Empfindungen auftreten, sich vereinigen und nach ihrem Verschwinden Vorstellungen zurücklassen"; but as the "unit of functional performances." Paulsen's discrimination of contents and consciousness strongly suggests Brentano's distinction between "Inhalt" and "Akt." A different interpretation of the reference of mind to the object is suggested by Nunn (2), who asserts in the name of "realism" that sensation carries with it "a guarantee of the extra-mentality of its content." Nunn's discussion, which turns chiefly upon the physical existence of secondary qualities, uses the term "sensation" not in the current psychological sense, but in the sense common to British philosophers. Nunn's defense of realism leads Schiller (2) to object that the *validity* of perceptual knowledge is guaranteed rather by the pragmatic method of test and selection than by the mere announcement of the object's existence.

Useful alike to psychophysics and to analytical psychology is Reimer's (5) critical and historical study of the concept of intensity in its psychological application. Reimer reviews the vicissitudes suffered by the doctrine of magnitude since Herbart gave it a place

in psychology, and after considering the numerous attempts to reduce intensity to some lower category, he arrives at the comforting conclusion that the attributive use of intensity has held its own against all criticism.

Sanford (6) sketches "the functions of the several senses in the general mental economy," concluding that "from touch we get the world of space and material reality, and force acting upon us; also, from motor touch, energy, active efficiency and freedom; from vision we get space and the world of things; from hearing we get our symbolic machinery of thought; from the general and organic senses, our most intimate intuitions of ourselves and the basis of our emotions."

Continuing his studies in sensory inhibition, Jacobson (1) discovers that odors generally suffer (for two out of his three observers) in intensity when attention is strongly concentrated upon an inhibiting sound stimulus; but that the inhibition is probably due to accessory, adducent processes rather than immediately to the sound itself.

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VISION—GENERAL PHENOMENA

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In his excellent study of visual acuity and illumination Rice (30) finds that white light yields the highest acuity, red (and probably yellow) is but little inferior, green is much inferior, and blue is still somewhat below green. With "daylight acuity" taken as the standard unit, three-quarters acuity is yielded by an illuminating intensity of 8 to 10 meter-candles; "with a reduction of intensity below this point the acuity decreases rapidly, and with an increase of intensity beyond this point the acuity rises very slowly, unit acuity being attained with an intensity of from 40 to 50 meter-candles . . . after unit acuity is attained, further increase of intensity shows practically no gain in acuity." A very strong case is made out for the merits of flicker photometry for all heterochromatic comparisons. It appears that in the flicker method of comparing brightnesses no Purkinje phenomenon is encountered; and that with exception "of prolonged exposure to red, the fatiguing of the eye by any color did not produce any change in the luminosity sense" for that color! If this is true it speaks strongly in favor of Langfeld's contention that there are two kinds of brightness-judgement, and implies that the flicker method calls only one of these into play.

Now Zahn (33) discovers that the brightness-distribution of spectral colors *on the fovea* (as obtained by finding at what intensity, under light-adaptation, a very brief stimulation of 1/500 sec. ceases to show color) is virtually identical with the distribution as measured by von Kries's "periphery-values" (light-adaptation and "totally color-blind periphery" of retina), and with the distribution as measured by Siebeck's "minimal field brightnesses" (light-adaptation and *very* small paracentral field). The flicker method gives the same distribution (30). This kind of brightness may be due to cone-vision: while the other kind of brightness (which gives the Purkinje phenomenon, except on the fovea) may be due to rod-vision. (Zahn calls his brightnesses, gotten by the method described above, "minimal time brightnesses.") Furthermore the Zahn-von Kries-Siebeck-flicker brightness distribution agrees closely with the distribution as

found by Frauenhofer and König using direct color comparisons ("specific judgments of brightness") (**33**). Zahn agrees with von Kries "that the physiological substratum of eccentric colorless vision is also present on the fovea, while here the basis for color determinations is *added*."

Nevertheless Rice inclines to refer the "luminosity sense" to the rods, and the form and color sense to the cones (**30**, p. 50). It may be *inferred* from Rice's work that the diminished acuity found for low intensities (except for the very lowest) is as much due to the *added* functioning of the non-form-perceiving rods, interfering with cone discriminations, as to any reduced functioning of the cones. Klein (**22**) would ascribe the poor form discrimination of the rods to the diffuse reflection of light from rod to rod when, as in dark-adaptation, they are no longer isolated from one another by the pigment-cells. But Klein is driven to assume that the idio-retinal light diffuses itself in a similar way! Cobb (**9**) treats of other impairments to visual acuity by means of light diffused through the eye. But he says: "There is no parallelism between the depression of vision for detail on the one hand, and discomfort and other visual disturbances classed under the head of 'glare' on the other hand, resulting from light source in the field of vision." As against von Kries's duplicity theory Sivén (**32**) renews his contention that the monochromatic spectrum is not gray but bluish, that santonin (yellow) vision does not affect the fovea, etc. The rods are therefore not color-blind: they mediate the perception of the short-waved colors. Rice finds them specially *sensitive* to short-waved light, yielding, however, only colorless sensations, while Edridge-Green (**15**) declares himself to "know of no fact pointing to the view that the rods are percipient elements." (He also finds it easy to observe the Purkinje phenomenon on the fovea.) Henri and Larguier des Bancels (**20**) present a valuable compilation of research data on threshold luminous energies (for various color sensations, on various parts of the retina, for different exposure times, etc.) and on the rôle of the visual purple. Ferree and Rand (**17** and **18**) promise work in which the sensitivity of the retina, area of the color-zones, etc., are to be measured in *energy units*.

The same authors (**16**) renew the discussion of colored after-images from stimuli in which no color is perceived. They find two methods for getting such after-images: (1) by presenting the (colored) stimulus while the eye (at first light-adapted) has not yet had time to become adapted to the reduced intensity at which this stimulus is

illuminated. Stimulus is then removed and the colored after-image develops while the eye becomes more and more dark-adapted; (2) by using a preëxposure of black (of same size as the ensuing colored stimulus), this giving a brightness after-image which fuses with the now presented colored stimulus and reduces its saturation (*i. e.*, makes it appear colorless). The after-image of this is now projected on a black screen, and is found to be complementarily colored. By this second method a colored after-image from a (red, yellow, green, or blue) stimulus in which no color was sensed is obtained in 100 per cent. of the cases. "The technique of getting a colored after-image from a stimulus in which no color is sensed becomes merely a matter of fusing the least favorable brightness quality with the stimulus color and the most favorable with the after-image color." Simultaneous contrast color was also got from red, yellow, and dark orange at an illumination sufficiently reduced to obliterate the color in the inducing stimulus. Method 1 (above) greatly facilitates this, for "color induction is greatly enhanced while the retinal change corresponding to dark-adaptation is going on." This compares interestingly with what Dunlap (11) calls the "Mach phenomenon." Ferree and Rand further believe that the "Purkinje-Brücke" phenomenon is a case of colored after-image from a previously unsensed color-contrast effect. The authors lay stress on Purkinje's observations as to the way in which changes in brightness affect the saturation of colors. Day (10), in a paper partly undertaken as a response to Ferree and Rand, finds no satisfactory evidence to confirm their results. The reviewer finds the work of Ferree and Rand more convincing than that of Day. Lohmann (24) studies a phenomenon opposite to that used by Ferree and Rand in their method (above), *i. e.*, he studies the decreasing difference-threshold for brightness as the eye, at first dark-adapted, adjusts itself to a brighter illumination. This difference-threshold settles to its lowest (and steady) point in about 12 seconds: while the threshold of sensation continues to improve for 60 to 80 minutes according to the intensity of illumination to which the eye is becoming adapted.

Rand's paper (29) is on simultaneous contrast which she calls "induction." She finds that "induction" depends (in positive sense) on the differences between the brightnesses of the adjoining fields, increases with distance from the fovea, and (within the limits experimented on) with decrease of illumination. The reviewer does not think that the author's general statement is justified, viz., that a white field adds more black to a patch of color seen on it, than a

black field adds white to a similar patch of color; nor does the reviewer see how "induction" was prevented from affecting the surface which was employed to measure this very "induction." Brückner and Kirsch (5) find that the time-threshold of color perception increases with the brightness of a gray stimulus (of same size and position as the colored stimulus) which both precedes and succeeds the colored stimulus. The gray that succeeds modifies the time-threshold more than the gray which precedes the colored stimulus. Weber's law appears to hold of the difference-threshold between the gray and the colored stimulus. This paper seems to contain good quantitative work which ought to be available for comparison with subsequent researches, but which will probably not be available, owing partly to a perverse setting of the problem, and partly to the lack of standard units and conditions under which psychology so greatly suffers. In a subsequent paper (6) the same authors find that electrical stimulation of the eyeball gives (on both opening and closing the current) light flashes in three locations, according to the strength of the current—at the periphery, the center, and the blind spot. The threshold of this electrical stimulation, on the center and the blind-spot, is about twice as high for the light-adapted as for the dark-adapted eye (contra G. E. Müller, Nagel, Cords). But this can be shown only when the two eyes of one person are severally light- and dark-adapted simultaneously. Then the difference is more marked for supraliminal than for liminal stimuli. The authors believe that this heightened electrical sensitivity in dark-adaptation depends on conditions in the "central parts of the visual tract" rather than in the eye itself. Magnusson and Stevens (27) have an interesting paper on visual sensations due to stimulation by a magnetic field: the appearance is a narrow horizontal band of light moving up or down in the visual field. The papers of Edridge-Green (12, 13, 14, 15) and Hartridge (19) are brief, idiosyncratic, and unimportant.

Basler (1) finds that two successive visual stimuli may be recognized as distinct when a continued succession of the same stimuli at the same rate appears fused. In order to produce complete fusion the dark interval between the stimuli must be in the latter case about one third of what it is in the former case. Basler has found the same phenomenon in the sense of touch. The phenomenon whereby of two simultaneous visual stimuli, one central and one peripheral, the former generally appears in consciousness earlier than the latter is ordinarily referred to the attention ("prior entry"). Dunlap (11) finds that it can be excluded by careful fixation of the

eyes, and concludes that the illusion is due to eye-movement or a nascent innervation thereto. Using pairs of slightly unequal luminous lines which are to be judged as to their relative length, Lorentz (26) studies the number of such judgments that can be made when the material is exposed 135 σ. The threshold of difference is about twice as high for two pairs as for one pair. When more pairs are presented for judgment, it is not so much this threshold of difference (which is based on "equality" and "uncertainty" judgments) that increases, as rather the *measure of precision* that decreases. This latter decreases in geometrical progression as the "distribution of attention" (number of pairs to be judged—up to 4 pairs) increases in arithmetical progression. Where the material to be judged is heterogeneous (a pair of dots to be judged as to relative position, a row of dots to be judged as to their number, etc.) the measure of precision is improved. Thus the *Bewusstseinsumfang* is greater for heterogeneous than for homogeneous material. Baumann (2) studies the phenomenon (attributed to Fechner) of discs with black and white concentric patterns, which when slowly rotated show circular bands of color. The author gives this rule for the colors: "dark violet and blue tones when dark replaces light," *i. e.*, where black succeeds white, "brownish red and red tones when light replaces dark." Less *eindrucksvolle* (?) conditions "suffice to produce yellow and green." Rollett (31) interestingly describes an illusion of a flowing motion (like "falling snowflakes") across a pattern of closely-ruled parallel (or also reticulated) light and dark lines.[1] The flowing can be seen on a larger area of the visual field than that occupied by the inducing pattern. Rollett offers an ingenious (and to the reviewer not unplausible) theory of local cross-currents on the retina which equalize the (parallel lines of) different electrical potentials produced by the stimulating pattern. This is in harmony with the optical (electrical) resonance theory presented by Castelli (8), who says that "the dimensions of the retinal pigment granules of the frog are of the same order of magnitude as the wave-lengths of monochromatic rays comprised in the visible part of the solar spectrum . . . they vibrate at various periods according to their sizes." Carr (7) describes a case of after-image of a human eye (which the experimenter had been steadily fixating under special illumination) which after-image, of almost hallucinatory distinctness, was seen several times to *wink* (as the actual eye had of course done during the observation). Lohmann

[1] This is the same phenomenon as "the illusory dust-drift" described by A. H. Pierce in *Science*, 1900, 12, 208–211.

(25) concludes from some phenomena connected with a case of flicker-scotoma (*migraine ophthalmique*) and with colored audition, that color mixture and color contrast "are not necessarily solely dependent on processes in the peripheral visual apparatus." But Bourland (4) believes that *migraine ophthalmique* is almost always associated with hysteria: in that case it would be hazardous to draw conclusions regarding the field of sensation from any peculiarities of the scotoma. Kahn (21) describes an ingenious means of looking at one's own two eyes combined in a single image. The corneal and lens reflections are seen in this image in stereoscopic relief, and it is conceivable that this will be a very accurate means for studying the accommodation of the lens. Another means to this same end may be found in the fluctuations of chromatic aberration as mentioned by Rice (30, p. 37). Bocci (3) believes that the circular (Müller's) fibers of the ciliary muscle contract for near accommodation; and that the radial fibers (Brücke's) also actively contract for distant accommodation. The latter muscle at the same time stretches the choroid coat and the retina itself. Kugel (23) believes that persons suffering from anisometropia and from strabismus see predominantly if not solely with one eye—that one which gives the clearer vision. Anisometropes should not wear glasses attempting to correct the vision of the *weaker* eye, for the images given by it can never be like those of the other eye, and thus the more definite the former are made by the aid of glasses, the more painful will be the retinal rivalry that is set up. Munsell (28) presents a valuable scheme for the classification and designation of hues, shades, and chromas; with a notice of some carefully prepared standard color-charts which are now obtainable of Wadsworth, Howland and Co., Boston, Mass.

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VISION—PERIPHERAL AND FOVEAL

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The literature covered in this report is pretty evenly divided between medical and psychological interests.

Pick (7) discusses a disturbance of the macula which occurs in cases of myopia. It had been mentioned first by Foerster, later by Wecker, and was described at length by Fuchs. Pick confirms in general Fuchs's diagnosis and adds some details with regard to prognosis, cause of disease, etc. A brief summary of Fuchs's description is as follows. In some cases of myopia a black spot appears in the macula which is different and distinct from the customary macula alterations. The abnormality begins with a very sudden visual disturbance: visual metamorphosis, shrinkage of objects, undulating contours, positive scotomata, etc. In the beginning there is a small central scotoma which later increases in area until reading is rendered impossible. Objective examination shows a black spot, circular in form, sharply outlined, and reddish in the middle which later increases in size and brightness, and results in atrophy. Fuchs concludes that the blood vessel layer of the retina is the seat of the abnormality. This layer of the retina in the region affected becomes calloused and opaque. Hemorrhage, which other writers have considered to be the cause of the disturbance, is neither its cause nor an invariable accompaniment.

Pick adds to Fuchs's discussion the following data. (1) The seat of the disease in the beginning is not located in the fovea but directly above it. Frequently in increasing in size the black spot spreads to the fovea; more often, however, it spreads on either side, forming an open half-ring under the fovea. (2) Hemorrhages are frequently observed but not in every case. They do not seem to affect the course of the disease. (3) Using the eyes increases the abnormality; resting the eyes lessens it. (4) The disease generally occurs during middle life. The younger the patient, the better are his chances for recovery. (5) The degree of myopia has a great influence both upon the presence of the disease and the extent of the disturbance. The lower the degree of the myopia the more favorable is the prognosis. (6) The prognosis is not always so unfavorable as Fuchs found. The central and the paracentral scotomata always remain, but they often continue to be so small that close work can be done and small type be read.

Childs (1) makes an appeal for the inclusion of mapping the visual field as a part of the routine procedure in ocular examinations. This feature has very little value in diagnosis unless the norm of the patient is known. This ideal cannot be hoped to be attained in case of all people, but it can at least be attained for those who come into the hands of the oculist or the medical inspector. He emphasized the fact that the norm for the individual must be had to serve as the basis of comparison. A norm based on an average for a large number of cases will not serve this purpose.

Williams (10) describes a quick method for testing for reversal of the limits of sensitivity for red and blue in cases of intracranial pressure on the optic nerve. As a diagnostic this reversal of limits may indicate intracranial tumor, hemorrhage, nephritis, diabetes, etc.

In cases of hemianopsia it is frequently reported that the visual field bulges in the macular region, *i. e.*, instead of ending sharply at the vertical meridian passing through the center of the macula, the sensitivity of the macula beyond this meridian is retained over all or part of its area. The phenomenon, however, is in some dispute. Henning-Rönne (5) investigates 27 cases and finds the phenomenon in each case. He reviews the explanations that have been given of the phenomenon and advances one of his own. He believes that the macula shows sensitivity in these cases merely because it is normally more sensitive than the extramacular region. That is, while the disturbance is sufficient to render the extramacular region insensitive, it has not been great enough to destroy the sensitivity of the macula.

Rönne (9) discusses the relation between peripheral visual acuity and color sensitivity in certain cases of atrophy of the optic nerve and points out the usefulness of this relation for purposes of diagnosis. The report of his work may be divided into three parts. (1) He determines the relative acuity of seeing at different points in the peripheral retina. (2) He discusses the results of his work on acuity in its relation to hemianopsia. (3) He investigates the relation of color sensitivity to visual acuity in cases of atrophy of the optic nerve, and compares this relation to that found in the normal eye.

Van der Hoeve (6) took measurements of the size and position of the blind spot for 100 emmetropic eyes. The average position of the center of the blind spot in the eyes examined was 15° 33′ 47″ to the nasal side of the fovea, and 1° 40′ 41″ below the fovea. The

average horizontal diameter of the blind spot was 5° 42′ 55″; the average vertical diameter, 7° 26′. These values reduced to linear terms correspond very well with the measurements of the papilla of the optic nerve made by Müller, Charpentier, Schwalbe, Techot, Koster, Druault, Volke, and Kölliker. Around the blind spot a zone $\frac{1}{8}°$–$\frac{3}{4}°$ wide was found which was relatively blind to white; and surrounding this a zone $\frac{1}{8}°$–$\frac{3}{4}°$ wide relatively blind to color. In this latter zone the colors were not always seen as grays but were sometimes seen as a different color tone. For example, red was seen as rose, and blue as green or violet. The transition of tone, however, was not regular, as was found by Ovio.

Polimanti (8) describes an observation dealing with the sensitivity of the fovea at low illumination. Arago has said that stars seen in indirect vision fade away as their images are brought to the fovea. Von Kries observes with a dark-adapted eye at twilight small blue and white spots on a black ground. These spots are seen clearly so long as no one of them is fixated. When one is fixated, it becomes hazy and indistinct. The phenomenon becomes more marked in increase of dark-adaptation. Polimanti repeats Von Kries's observation by moonlight and gets similar results. He believes with Von Kries that the cause of the phenomenon is the difference of the sensitivity of the rods and cones at low illumination. The presence of the rods with their visual purple accounts for the sensitivity of the peripheral retina and their absence in the fovea for its insensitivity.

Dittler and Koike (2) attempt to get an estimate of the increase of sensitivity of the retina to colorless light with dark-adaptation and to compare the rate of increase for the fovea and the extra-foveal regions of the retina. Hering's method of double images was employed by them in this work. The procedure was as follows. The observer sat in a room well-lighted by daylight for 10 minutes. A dark bandage was then placed over one eye for a length of time depending upon the degree of adaptation wanted in the experiment. The subject then entered a dark cabinet in one wall of which was a small opening to admit the stimulus light. This light came from a white screen behind the opening lighted by a 100 c.p. Nernst lamp. The light from the Nernst was first passed through a blue-green filter to render it whiter. A fixation-point was taken so that an image of the stimulus fell on the fovea of the dark-adapted eye, and on a point slightly displaced from the fovea on the light-adapted eye. Conclusions as to the relative rate of adaptation in the light- and

dark-adapted eye were drawn from a comparison of the brightness of these images. It is obvious that the right to draw these conclusions rests on the assumption that when both eyes are equally light-adapted, the image falling on the fovea of one eye will be equal in brightness to the image slightly displaced from the fovea in the other eye. This is a pretty broad assumption, but Dittler and Koike claim to have found it to be true in previous experiments. Three lines of investigation were undertaken. (1) The shortest period of adaptation that will increase the sensitivity of the eye to the stimulus was determined. This was found to be 10–12 seconds. (2) An attempt was made to get a method of measuring in terms of the intensity of the stimulus how much the eye had increased in sensitivity as a result of the different periods of adaptation. This was done by cutting off the light from the more sensitive eye in known amounts by means of smoked glass until the two images were of the same brightness. It was found that after 5 minutes of adaptation, the light had to be cut down for the dark-adapted eye to $\frac{1}{5}$–$\frac{1}{8}$ of its original intensity; and after 30 minutes of adaptation to $\frac{1}{14}$–$\frac{1}{20}$ of its original intensity. (3) A few experiments were conducted to compare the rate of increase of sensitivity of the central and peripheral retina. As far as the work was carried, it was found that in dark-adapting the retina increases faster in sensitivity progressively from center to periphery.

Dreher (3) gives a preliminary report of a method for determining what colors are invariable in tone either in passing from the center to the periphery of the retina or from low to high intensities. Some work is described and a discussion is made of the results obtained in terms of G. E. Müller's color theory in its revised form. The method is based on the assumption that if a light appears to be of longer wave-length in the center than it does in the periphery of the field of vision, a light of shorter wave-length placed in the periphery will match the central light. If, Dreher argues, in one region of the spectrum the central light is matched by a light of shorter wave-length placed in the periphery and in another region the central light is matched by a light of longer wave-length, there will be a light between these, intermediate in color tone, which should be seen the same in tone in both center and periphery. He purposes to determine what this intermediate light will be indirectly by means of a coördinate system, rather than directly by means of experiment. For a full description of this method one must consult the original. The following results were obtained.

In the series for the determination of colors invariable in tone for center and periphery of the retina, only one point in the peripheral retina was used, namely, a point in the nasal meridian 14° from the fovea. In determining by his method the colors which should be invariable in tone for both the center and this point, only one color was found. This occurred near the D line at λ 588.3. In the intensity series, only three degrees of intensity were used. The results of the method showed that three different wave-lengths should give colors invariable in tone for these three intensities. These wave-lengths varied slightly for different observers, and were in the region of the yellow-green, the green-blue, and the red-blue. For one observer, for example, they were at λ 566.6, λ 483.2, and λ 460.2. The important features of this article are the description of apparatus and the method of working.

As the culmination of a series of studies the object of which has been to standardize the investigation of the color sensitivity of the retina, Ferree and Rand (4) have undertaken to determine the retina's sensitivity to colored light in terms of radiometric units. Having completed their work of standardizing the factors extraneous to the source of light, they are now trying to secure better control of the source. Standardization of the source, so far, can be considered successful only with regard to the quality of the light. No adequate work has been done upon the standardization of the quantity of light. They believe this can be done only by means of energy determinations.[1] Moreover, energy determinations are not

[1] To standardize first of all requires a method of measuring. No other method is adequate for measuring the intensity of colored light. The photometric method, for example, can not be used directly for this purpose for two reasons. (*a*) Direct radiometric measurements of energy show that the relative values of the colors of the spectrum, as determined by the two methods, do not at all coincide. The photometric curve, for example, of the spectra of all light-sources of normal intensity is highest in the yellow-green and lowest in the red and blue. The radiometric curve of the visible spectrum of sunlight of the same intensity is, on the other hand, according to Langley, highest in the red near the C line and lowest in the violet; while the radiometric curves of most of the artificial sources of light, such as the Nernst, tungsten, and arc lights, are highest in the extreme red and lowest in the violet. (*b*) The relative photometric values of the colors of all spectra differ widely for different intensities of the same light-source. For medium intensities, for example, the curve is highest in the yellow-green and lowest in the blue. But as the intensity is decreased, the curve levels, while its maximum shifts to the green and its minimum to the red. In short, the photometric value of a color is not a constant but a variable function of its intensity. It is obvious, then, (*a*) that the photometric method can not be used to estimate the relative intensities of the colors of the spectrum even for a single intensity of light-source unless for each part of the spectrum considered a factor be determined

only needed to standardize the stimulus, but they are also needed that we may be able to express the sensitivity of the retina to the different colors in terms of units that can be compared. At present, we have no direct estimate of the comparative sensitivity of the retina to the different colors further than is expressed, for example, by the relative width of the collimator-slit that has to be used to arouse color sensation when a source of light of a given candle-power is used. This kind of comparison is obviously unfair because such different amounts of energy are represented from point to point in the spectrum that a given width of s it would admit many times the amount of energy at one part of the spectrum that it would at another. In short, no adequate estimation and expression of the retina's sensitivity to color, comparative or absolute, can be made by the methods now in common use.

In a preliminary note, Ferree and Rand outline the kinds of problem that demand the direct objective standardization and show that there is a need for the control and regulation of the stimulus in terms of a common objective unit of measurement, even in problems in which it is desired to make the intensity of the lights proportional to the sensitivity of the eye.

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which will transform the photometric into the radiometric value; and (*b*) that it can not be used over a wide range of intensities of light-source unless this calibration be previously made for each degree of intensity used.

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VISION—COLOR DEFECTS

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Color tests have again received considerable attention in England. The committee of the Board of Trade appointed in 1910 to enquire into the efficiency of the tests in use, print an extensive report (22) accompanied by minutes of evidence and records of experiments upon color-blind subjects. The committee finds "no evidence showing conclusively that defective vision has caused any appreciable number of accidents at sea"; but to provide against the possibility of danger in the future, the committee recommends certain modifications in the wool test, the addition of a lantern test, and the use of Abney's luminosity test with spectral apparatus in case of appeal.

Two memoranda of importance are published with the minutes of evidence. Burch (2) criticizes the official tests and suggests that if proper red, white and green signal-lights were used on ships, only the red-blind need be excluded from service, the other types (the green, blue and violet blind, after Young) being able to distinguish such lights. Burch describes a new form of apparatus for the display of lights, by means of which the conditions at sea may be closely simulated, and explains his method of testing color deficiency by fatiguing the eye with spectral lights. Rivers (23) calls attention to the recent German work upon minor color defects, and the prevalence of acquired color-blindness, and suggests that, since there are without doubt large numbers of valuable men in the service[1] whose color vision is below normal and who are nevertheless able to distinguish certain colors, the wise course to pursue would be to determine by extensive experiments just what the color discrimination of such persons is, and then to adopt, and standardize, by international agreement, lights which they can distinguish. Upon the information at present available, Rivers concludes that "cases of total color-

[1] According to the table printed in the minutes of evidence, page 140, during the years 1894–1909 only .8 per cent. of the candidates were rejected because of color defects.

blindness and of diminution of the luminosity of red lights (6, p. 460) are obvious sources of danger"; but that since the partially color-blind, and persons showing minor color-defects are able to distinguish red from white by its saturation, and blue from red or white by a fundamental difference in hue, danger of confusion in the discrimination of signals may be avoided by the alteration of the present green signal-light to a blue-green, especially if, as is commonly believed, color-defectives often show higher powers of color discrimination than the normal individual.[2]

Many persons interested in color tests have made minor contributions. Edridge-Green (4) refers to a series of cases in which color-blindness has caused dangerous situations at sea, and (5) describes his new spectral apparatus for showing one color at a time; Pryn (21) compares the color tests used in the navy with those recommended by the Board of Trade; Butler (3) emphasizes the need of annual tests to detect the rise of acquired color-blindness, four cases of which came to him within a month, and recommends the use of a good lantern test; Taylor (24) claims to have noted peculiarities in the face and voice of color-blind persons, peculiarities which sometimes plainly indicate the color defect before any tests have been made. "A color-blind person's face is devoid of warmth and humor; it is dull, still and monotonous in the sameness of its expression." Gray (9) suggests that color-blindness and a tendency to melancholia are both manifestations of the same fundamental condition of the neural material of the brain,—a condition analogous to high conductivity for nervous currents.

Nagel (19) gives a detailed description of the various methods of investigating the color sense with simple and complex apparatus, adding suggestions for the diagnosis of the different types of color-defect. By a series of experiments upon von Brücke, a protanope, von Brücke and Inouye (1) construct a curve showing the distribution of red and green values throughout the spectrum, making their calculations upon the basis of a series of equations, in which changing amounts of colors from different sides of the neutral zone are made to match a constant amount of neutral green. Zeeman (26) describes a relatively simple and inexpensive spectral apparatus suited for study, demonstration and clinical work, by means of which spectral colors may be shown singly or in any desired combination, and the

[2] Lieberman and Marx found a protanope clearly inferior to a normal subject in distinguishing differences in color quality, throughout the whole series of spectral lights. *Zsch. f. Sinnesphysiol.*, 1911, 45, 103–108.

wave-length, intensity and saturation of the colors used may be accurately measured. Zeeman's assistant, Weve, reports upon the use of this apparatus with normal and color-defective subjects. Weve concludes that, while slight variations in the proportion of red and green in the Rayleigh equation are likely to occur with normal persons, great variations indicate anomalous trichromatism—prot-anomalous when the proportion of green falls below 35 per cent. of the red, deuteranomalous when the proportion of green rises above 90 per cent. of the red. Dichromates accept the normal Rayleigh equation, and also such wide variations from it that either the red or the green may be accepted as equal to the yellow. Guttmann (**12**) reviews his earlier work upon the anomalies of the color sense, and demonstrates a method of experimentation designed to prove that the heightened sensitiveness to contrast found in anomalous trichromatism is due to changes in the eye itself, and is not the result of changes in the cortex. Edridge-Green (**6, 7**) describes his spectrometer for determining the number of monochromatic patches distinguishable by normal persons and color defectives, and reports the results of experiments. Normal individuals *name* only 6 distinct colors, but are able to *distinguish* 18 monochromatic patches; exceptionally gifted persons find from 22–29 patches; persons of slightly defective color sense find from 8–10 patches; the typically color-blind from 2–7. In his Hunterian Lectures (**8**) Edridge-Green outlines his theory of color-vision and the evolution of the color-sense, discusses the facts of color-blindness in the light of his theory, and makes recommendations for efficient color-tests, giving cuts and descriptions of his lantern and spectrometer.

Gertz (**10**) reviews the contradictory evidence for and against the existence of a central scotoma in total color-blindness, suggests a method of deciding the question by asking each subject to count series of equidistant dots, and (**11**) reports experiments upon a new case of total color-blindness,—a girl of 16, who shows photophobia, nystagmus, typical color-confusions, the Purkinje phenomenon and low visual acuity. Juler (**16**) reports upon 3 totally color-blind children in a sibship of 7, all three showing low visual acuity, photophobia and nystagmus. As all three children are very young, and show nystagmus, Juler was unable to determine whether there was any contraction of the field of vision, or a central scotoma. In spite of extended inquiry, the author failed to learn of any other cases in the ancestry of the children.

Nettleship (**20**) reports three pedigrees of red-green blindness,

which may have considerable importance for the discussion of the way in which this defect is inherited: (*a*) A pedigree showing color-blindness in both sexes and also a digital deformity; (*b*) a pedigree showing color-blindness in the younger only, of a pair of twin girls whose 4 brothers and 1 sister are all normal; (*c*) a pedigree showing color-blindness in the younger only, of a pair of twin girls whose only brother and 2 of whose 3 sisters are also color-blind; and (*d*) a pedigree showing color-blindness in 2 sisters and all their sons. Usher (25) reports an extensive pedigree extending over 7 generations, in which 22 males are believed, or known, to have been color-blind. No color-blind females were discovered and Bateson's assumption that color-blindness is a sex-limited character dominant in males and recessive in females is probably sufficient to explain all the facts known about the pedigree. The reviewer has tested 8 of the 11 living color-blind males in Usher's pedigree and finds evidence that in the fifth generation there was intermarriage between a deuteranopic and a protanopic stock,—a deuteranopic man married a normal woman carrying protanopia, which she transmitted to both her sons, while the man's deuteranopia was passed on by his normal daughters to all their sons. This would indicate that the two generally accepted types of partial color-blindness do not mix, but that each passes on in the sex-limited way suggested by Bateson.

Von Kries (18) gives a general survey of the facts of normal and abnormal color vision, with a discussion of the theoretical explanations of the facts. Jerchel (15) discusses the practical significance of red-green blindness for the individual affected: the possibility of æsthetic enjoyment of color, the probability of lowered efficiency in painting, on ships and trains, in the army, in the study of botany and chemistry, and in the various branches of medical specialty, basing the latter part of his article upon his own experience,—the author himself being a red-green blind physician. Hilbert (13) passes in review the various conditions under which sensations of color arise, and vainly tries to establish a dividing line between the physiological and the pathological. Clearly physiological are the color sensations aroused in the normal eye by ether waves of various lengths, certain of the color sensations aroused by the activity of the visual apparatus itself—contrast colors, negative after-images, etc.—and color effects due to the imperfection of the refractive media of the eye—chromatic aberration, astigmatism, cloudiness of the media and artificial coloring of the cornea. Clearly pathological are the color sensations experienced in acquired color-blindness due to functional or structural defects of the retina, the optic tract or the cortex,—in

color scotoma, in changes in the color fields and in the temporary color-blindness experienced in hypnosis, hysteria, epilepsy, and after severe wounds on the head, or following stimulation with a dazzling light. In the long list of color sensations which may be classed as either physiological or pathological, Hilbert includes color sensations arising from mechanical, thermal, electrical or chemical stimulation of the visual apparatus, a considerable group of sensations arising through the activity of the visual apparatus itself: the colored patterns seen against closed lids by Purkinje, König, Hilbert and others, under conditions which do not seem adequate to explain the phenomena; the color sensations aroused by toxic agents; the non-complementary negative after-images reported by Aubert and Hilbert; and the color sensations experienced in congenital color-blindness. In (14) Hilbert reports 6 rare cases of colored vision accompanying pathological conditions: yellow vision with chorioretinitis albuminurica, during pregnancy; brown, yellow, red and green vision with chorioretinitis of unknown origin; yellow vision from mushroom poisoning; green vision after an overdose of santonin; a violet outline around all objects for about 3 minutes upon awakening from rest after strenuous and long-continued work; and the persistence for several days of 2 oval green specks about as large as peas, appearing on the outside of the visual field of the right eye. Köllner (17) gives a detailed study of the kinds and causes of acquired color-blindness, and shows how this knowledge may be of great clinical value in the diagnosis of disease. Blue-yellow blindness occurs with diseases of the retina, especially those in which there is an exuding process. Acquired red-green blindness indicates some much graver disorder and may be a sign of reduced functioning at any point along the optic tract from the retina to the cortex. It is not an isolated color-disturbance, but a middle stage between normal vision and total color-blindness, and is generally accompanied by loss of visual acuity and lowered sensitiveness to light. The location of the disorder must be determined by the defects in the visual field—central scotoma, bilateral color-hemianopsia, etc. Acquired total color-blindness has much less diagnostic value, since it may arise in many ways—as a final stage of red-green blindness, as a result of the combination of some form of congenital color-blindness with an acquired defect, as a result of loss of color-memories, etc. Chromatopsia (colored vision), on the other hand, has considerable diagnostic value, since particular colors are ordinarily seen with particular disorders.

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HEARING

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In 1908 Liebermann and Révész reported certain anomalous results obtained from a study of the paracusis suffered by the first-named investigator (6). They found, in brief, that pseudo-tones which appeared in the region above e^2, were apparently corrected when any two tones, one or both of which were pseudo-tones, were sounded together. This phenomenon was termed "orthosymphony." The investigations were made with the harmonium, organ, piano, and tuning-forks. The pseudo-tones, when tested alone, were found to be constant for fairly long intervals of objective pitch. For instance, c^2–b^2 all sounded as g^2. During orthosymphony it was found that the beats were normal, and that, upon analysis, the subject could again detect the pseudo-quality of the tone or tones corrected. In the moment of analysis it was not found that the fusion effect of the interval under investigation was in any way altered. It was therefore concluded that the orthosymphonic effect must be independent of the cochlear resonators assumed by Helmholtz. Tests were also made with another paracustic subject which, while not so convincing as those with subject L., were still sufficient to demonstrate the phenomenon. Orthosymphony was obtained with the octave, but not so well with the other intervals, and it was concluded that the observer tended to base his judgments upon an analysis of the components.

Investigations made a year later (7) indicated some exceptions to the results of the preceding report. Intervals were found for subject L. in which orthosymphony was not produced. The pathological conditions of the subject had changed. In April, 1911, the paracusis was in a chronic state, without becoming noticeably worse. Experiments were begun again, and it was found that part of the pseudo-tones gave normal accords with all other tones, while with others it depended upon the interval used. Tests were made with pure tones, which demonstrated by the persistence of the phenomenon that it was not due to an illusion occasioned by the presence of overtones.

The authors now reject the assumption of the earlier paper that the pseudo-tone appears normal in the accord, and an explanation for the phenomenon is sought in the differentiation of the pitch-attribute into two factors: *pitch*, properly speaking, as referring to the relative highness or lowness in the tonal manifold, and *quality*, or that factor which enables us to establish resemblances and differences in the tones of the scale. Applying this differentiation, it was found that the paracusis affects quality, but not pitch. This important conclusion was tested by a variety of experiments. By simultaneous presentation the subject was able to select a tone in the paracustic region in octave relationship with a tone normally heard as accurately as the normal ear hears. Furthermore, investigations with special instruction indicated that judgments of interval, when made with reference to quality, were passive and naïve; when made with reference to pitch, they required time and consideration. Naïve judgments of quality were best in the lower range of pseudo-tones; for pitch, however, they were better in the higher range, because in the lower range, where the falsification was less, the difference between pitch and quality was not so evident as in the higher ranges. A third evidence appears in the fact that while judgments of interval were often false, judgments of *distance* between tones approached correctness, the subject often noting that the pitch distance did not coincide with the qualitative interval.

In a third paper (8) the authors have recorded a peculiar phenomenon in the lower range of L.'s unfalsified tones. In was found that the successive tones C_1–C often gave the effect of the fourth, C_1 being taken for g. This phenomenon also persisted after overtones had been eliminated. The effect was not constant, as in the case of the pseudo-tones of the higher region, but appeared rather as an extremely labile variation, always dependent upon a comparative tone, and held by the authors to be of central origin. Again it was found that the pitch remained constant, while only the quality suffered alteration. When C_1 was taken for g, and then the objective G_1 was sounded, the latter was often judged normally, and not identified with the falsified C_1. Sometimes C_1, appearing as g, changed again to c, and the subject noted that the pitch was not thereby altered. Distance judgments, as made in the previous experiments, also substantiated this distinction between pitch and quality.

These papers are a striking example of the assistance which pathological cases may render to the analyses of normal psychology.

Weld (15) has made an interesting contribution to the study of musical enjoyment by his analyses of the introspective results obtained from eight musical observers who listened to instrumental selections played on a phonograph. An effort was also made to correlate these results with plethysmographic and pneumographic records which were simultaneously procured. No positive correlations were obtained, however, which had direct bearing upon the distinctly musical character of the observer's attitude, save in a specially instructed series where breathing was correlated with musical phrasing.

The introspective results are described under six headings: visual imagery, auditory imagery, motor reactions (actual or imagined), reactions to descriptive music, emotions and moods, and individual differences. The striking thing about visual imagery was the special manner in which it was related to the music in the case of three of his observers. This imagery was entirely involuntary, being determined by the musical "movements" which it invariably followed. "We are convinced," he adds, "that the traditional laws of association are powerless to explain the visual imagery which our introspections have revealed." Auditory imagery was less frequent. It was detected in the reports of half the observers, but conspicuously only in one case. Here it seemed to serve as a sort of anticipatory means of criticism, this observer being the most erudite, in a musical sense, of those engaged in the work. In this connection the statement is made that it does not seem "necessary to show that the auditor who possesses a profusion of auditory imagery will *ipso facto* be better qualified not only to detect the recurrence of *motifs*, but also to appreciate the composer's modifications and exploitations of his original *motifs*." While realizing that in perception and recognition the image is not indispensable, the author apparently adheres to the belief that in difficult and non-mechanized recognitions some relevant imagery, in this case either auditory or a surrogate, must be present. Bodily movements, actual or imagined, were reported by all save one observer, and that one invariably reported visual images which were themselves full of movement. This finding is made the central feature of the results. It is regarded as the subjective basis for the sense of rhythm, which, however, is distinguishable from the sense of *Takt*, the latter being often absent. When present it is added to the sense of rhythm. Whenever the musical movement becomes objectified some corresponding movement takes place in the body of the listener, and it is suggested that eye movements may serve largely in this respect.

An interesting section is given over to the introspective reports of a piece of descriptive music, which seem to demonstrate the impossibility of arousing anything like a definite idea of the setting intended, except, occasionally, by the introduction of imitative sounds. Either pleasantness or indifference was found to be the rule with reference to the feeling side of the experiences. Instead of experiencing displeasure, the hearer merely lost interest when pleasure was not aroused. A sense of movement was also noted which may be described under Wundt's category of excitement-repose. The frequency and independence of feelings referable to this dimension lead the author to believe that it is a justifiable addition to the categories of feeling. The detailed study of individual differences which follows we need not here recapitulate.

In his conclusion, the author states that he has "endeavored to include every important item which seemed to have significance for the appreciation and enjoyment of music," and expresses the surprise of both himself and his co-workers "at the invariable presence and apparent functional significance of their kinesthetic experiences, both sensational and imaginal. . . ."

Interesting and suggestive as these results are, one may not impertinently raise the question: How far has the author actually succeeded in contributing to the psychology of musical enjoyment? It is evident that he stands squarely upon the sensationalistic basis, and therefore considers his task achieved when he has analyzed the sensations and feelings which his auditors experienced. But there is another way of looking at these matters, and to one who does not regard sensation as the *alpha* and *omega* of psychology, the transferal of stress from audition to kinesthesis indicates but a shift of interest from the unanalyzed data of audition to certain concomitants which may, it is true, be universal accompaniments of the musical experience. One looks in vain for any reference to what Stumpf has called "musical thought." Intellectual attitudes are regarded entirely as critical in their nature, thus becoming contributory rather than realizing factors in the appreciation. To be sure, one could not expect analyses of musical thought after periods of listening which lasted from $3\frac{1}{2}$ to $4\frac{1}{2}$ minutes. But one may properly object to the identification of musical enjoyment with such gross expressive contents as come to light in these analyses. It is also noteworthy that the involuntary movements recorded by pulse, volume and breathing showed no correlation with the experience, and there was no objective control for the kinesthetic effects which the introspections revealed.

Now, it is not a matter of indifference whether these latter effects were actual or imagined. If they were actual, it might have been possible to register them. As the author mentions, many theorists have assumed certain correlations with involuntary movements such as he was unable to detect. It may be the same with movements of the voluntary muscles. If these kinesthetic effects should, in fact, prove to be but crude approximations of the delicate movements of the music, a much more detailed introspective study would appear to be desirable before any significant correlation between these movements and their imaginal counterparts could be said to have been established.

Auerbach's *Grundlagen der Musik* (1) is intended primarily for popular consumption. It embodies a series of eleven lectures delivered at the University of Jena, and treats of the principles of music from a purely physical point of view. Although, for the psychologist, such a setting is distinctly incomplete, he will nevertheless find here, in concise form, a clear presentation of the main facts which physics is able to adduce concerning the various kinds of sound vibration in the various media which produce and conduct them. Of especial interest is the treatment of the musical instruments and their physical properties. Objection may be raised to the treatment of combination tones as entirely objective. The possibility that these tones may be produced in the ear is briefly dismissed with the statement that "an der objektiven Existenz der Kombinationstöne ist nicht mehr zu rütteln."

As might be expected, the theories of Helmholtz with reference to hearing and harmony are upheld. In the former instance, no other conception is mentioned. In the latter case, a paragraph is devoted to the theory of Oettingen, and a brief destructive criticism is accorded the views of Stumpf. The Helmholtz explanation of harmony by recourse to the presence or absence of beats is held to be the only theory which is scientifically based. All psychological theories are rejected because they are said to depend upon gratuitous assumptions concerning unknown brain states. As for metaphysical theories, they are, in the nature of the case, both indisputable and undemonstrable. In treating the problem of tonality, however, the author innocently reveals the insufficiency of any purely physical theory to account fully for the facts, since, in explaining melody, he is forced to refer to the action of memory, and assume "psychic beats" to explain the agreeable and disagreeable impression from related and unrelated tones in succession. Again he finds it necessary to

make a tacit reference to "epistemology" in justifying the statement that "melody is but temporarily distributed harmony," since he admits that historically melody has the priority.

Stumpf's interesting volume on the beginnings of music (14) has already been treated in this journal with a special review.[1]

Guttmann, in a brief and rather general paper (4) on the investigation of the voice, urges the need for greater understanding of the real problems of singing,—physiological, psychological and historical,—on the part of investigators. He substantiates his contention by reference (1) to the artificial results which are obtained under the ordinary conditions of medical examination; (2) the inadequacy of recording instruments; and (3) the lack of control and proper analysis when a singer tests his own voice. Certain technical problems are discussed, such as that of "throwing" the voice at a distance, and the question of a singer's "register." The paper concludes with some interesting suggestions regarding false intonations with various intervals. In particular it is noted on experimental evidence that trained singers falsify the fifth more often than the third. This the author thinks may be due to the fact that the fifth is regarded in present-day musical practice as "empty" and unsatisfactory, whereas, he fancies that a singer of the Middle Ages would have found no such difficulty attaching to the then more favored interval. It is also stated that false intonations are likely to appear in those regions of the scale where the singer must pass from one "register," or muscular setting, to another.

Three articles may be mentioned which bear upon the conductivity of sound in the head. Zimmermann's experiments with microphone and a "prepared" ear (17) contradict v. Eicken's results concerning the importance attaching to the bones of the ear. He found that the sound goes directly through the skull bones, especially the *promontorium*, to the fibers of the end-organ. Wolff (16), testing the results of Struyken, who concluded that the highest monochord tones could be heard better through the skull bones than *via* the ear, finds this to be true for deaf, but not certainly so for normal, ears. With tones of lower range he found that normal ears hear equally well by bone or air conduction; the deaf, however, better *via* the air. He concludes that this distinction must have its basis in the function of the middle-ear apparatus. Nikiforowsky (12) criticizes the methods of studying conductivity by means of the observer's judgments. These results tend to show that the bones of the skull

[1] Cf. this journal, 1912, 9, 200–203.

conduct better than the softer parts, but they are vitiated by the fact that one judges on the basis of the duration of the tones heard, which depends upon individual acuity of hearing and attention. The present investigation measures the sound with a microphone especially constructed for the purpose and very perfectly isolated in a lead receptacle. There were three series of experiments. The first studied the effects of sounds produced by the subject speaking the vowels with chest tones and in falsetto. With the former (ordinary speech) the sound flows in greater part through the natural openings of mouth and nose. The softer parts of the face were found to conduct better than the rigid parts of the skull, the amount coming from the skull being less than 1/10 the amount coming from the ears and softer parts. With falsetto tones the same general condition prevailed. The second series studied sounds produced by a tuning-fork applied to the center of the skull. Opposite results were obtained. From the rigid parts, especially the ears, the sound flows with greater energy than from the softer parts. The third series was intended to study the flow of energy when the sound stimulus was at a distance, but the conditions were unfavorable, owing to insufficient energy of the sound, and the results were not significant.

A comparison between the availability of the Galton whistle and the Schulze monochord for determining the upper limit of hearing, made by Helmholz (5), substantiates, with 100 normal subjects, Schulze's result that the limit is approximately 20,000 v.d. The author was able to control the Galton whistle by means of a water-drum bellows of constant pressure, and thus obtained from it approximate uniformity with the monochord results. At about c^7 the whistle was the better instrument, but with the monochord the upper tones were more constant and allowed the limit to be set more definitely.

Marage makes an interesting contribution to the study of the sounds of consonants (9). The consonant is defined as a supra-laryngeal noise which precedes or follows the intermittent aero-laryngeal vibration which one calls a vowel. Speech consists of two sorts of vibrations, periodic, and non-periodic. Photographic records of the consonants revealed two classes of tracings: (1) two-part tracings, in which the mouth and nose intervene to give the nasal sounds, and (2) one-part tracings, which are formed in the mouth. Duration was found to be less important in consonants than in vowels, analysis showing that vowels continue 10–20 times longer than consonants. One may understand from this why, at the beginning of hypoacusis, certain parts of a word are heard less well than

others. In otitis sclerosis the hearing of vowels is retained best because of their longer duration. Two practical applications are made of these results. First, the importance of teaching vowels and consonants together, which means a great saving in time for the pupil. Second, that in order to avoid the sudden parting of the vocal chords (*coup de glotte*) experienced by singers in beginning an exercise on a vowel, it is only necessary to add an explosive consonant to the vowel in order to reduce the explosion materially.

The same author contributes to our knowledge of deaf-mutes (10). The results which he has obtained in curing the deaf with the vowel-siren, lead him to attack the usual methods of classifying the deaf on the basis of hearing for noises, tones and words. It is possible for a deaf-mute to hear noises very well, but not tones or words. That the degree of deafness is not so important is illustrated by the citation of three cases. The first had passed for half-deaf, the second for almost completely deaf, and the third for absolutely deaf. Yet after treatment the last named case was able to hear and understand phrases at one meter distance. The second case was able to make similar progress in less time than the third, being younger, but the first case proved refractory, as the tests showed "gaps" in his hearing. One should therefore classify with reference to the form of acuity. If gaps in the hearing occur, the siren treatment will prove unavailing as a means of training the acuity. Even in favorable cases where the acuity is markedly increased, it often requires much time and patience to secure comprehension for the sounds heard.

Marx reports certain results from the destruction of the cochlea in guinea-pigs (11). The animals were first tested by Urbantschitsch's closed-pipes and the Preyer ear reflex, then the cochleas were destroyed. In many the ear reflex remained for high tones, although the destruction was afterwards found to have taken place more or less completely in all parts of the cochlea. It was never found that the reflex was lost for high tones, and retained for low tones, which, the author concludes, is no support for the Helmholtz theory.

The following two contributions from the field of physics are of some interest to psychologists. Stewart's paper (13) is based upon certain mathematical considerations in extension of Lord Rayleigh's work on the intensity of sound at different distances when the source is located upon a rigid sphere. Passing over the applications to architectural construction, the author makes some interesting deductions with regard to the apparent intensity of sound from a source at a distance, as dependent upon the position of the head. The conclu-

sions are: (1) that the apparent intensity is always greatest when the head is turned with an ear towards the source; (2) the variation of the apparent intensity with the position of the head is more marked the nearer the source to the hearer; (3) with decreasing wave-length the maximum value of apparent intensity occurs with greater sharpness; (4) the maximum variation of apparent intensity is least with lowest tones; (5) the maximum variation of apparent intensity does not increase without limit, for at wave-length 30 cm. it has already begun to decrease. Brown reports some experimental results of an attempt to secure an accurate picture of a sound wave from a vibrating flame (3). This is known to be difficult, owing to the complicated action of the flame. The plan of the investigation consisted in vibrating a flame with sound waves of known form, and modifying the conditions until the wave form was obtained. By the method of a soot-tracing the author was able to detect in his records a thread of soot, apparently coming from the center of the flame, which exhibited the only longitudinal vibration of the flame, and nearly approximated a sine curve. With photographic records of the flame he discovered that the lower luminous edge seemed to be exceedingly sharp, and to vibrate with considerable amplitude. Records of this part of the flame were found to agree very well with those obtained by the soot-tracing, which indicates that with more refined methods an accurate record of the sound wave may be obtained.

New apparatus for acoustical experiments is reported by Bentley, Boring and Ruckmich (2). Comments upon these instruments have already appeared in the BULLETIN.[1]

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TASTE AND SMELL

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For the years 1911 and 1912 the writer has been able to find no new work upon taste reported in English, German, French or Italian, and has been scarcely more successful in the case of smell. Readers of Swedish may note that a ten-page paper upon "*dektriska smaken*" appeared in the official publications of the University of Upsala for 1911.

Zwaardemaker (3) devotes to the jubilee of Onodi a brief paper on the effect of ultra-violet light-rays on odorous gases. This paper represents a rather laborious series of experiments. In the latest form of Zwaardemaker's precision-olfactometer (which the writer has not seen in any American laboratory), the experimenter inhales not directly from the bore of the odorous cylinder but from a retaining-chamber of glass, which is equipped at the top with a short tube for insertion in the nostril and which is connected horizontally with the

bore of the odorous cylinder in such a way that a current of air can be readily drawn through both by a Bunsen air-pump. For these recent experiments the end of this glass chamber opposite to the one from which the scent issued was filled with a quartz lens of about seven diopters and in the focus of this lens was placed a mercury lamp (in the later experiments a quartz-lamp, which, however, has a certain serious draw-back). The odorous gas subjected to the parallel rays of light amounted in every case to two olfacties, so that if its effectiveness were reduced by half, it would become a merely liminal stimulus. Representatives of all Zwaardemaker's classes of smells were tested and the time required for virtual deodorization was recorded. Among the scents which suffered most are skatol, pyridin, valeric acid, and oil of turpentine, which were deodorized respectively in forty-five, ten, five and five seconds. Nitrobenzole and oil of pock-wood proved refractory to the influence of the light. It is impossible to draw conclusions from these experiments in regard to the relation either of chemical composition or of smell-quality to power of resisting the disintegrating effect of ultra-violet light. They prove, however, that the ultra-violet light contained in ordinary daylight is a most potent agent in the deterioration of scents.

Laval (1) summarizes a thesis offered by Itie at Toulouse in 1909. This thesis is largely concerned with methods and instruments for testing the freedom of the nasal air-passages and the course of the nasal air-currents. The writer of the thesis tested 370 subjects with the manometric rhinometer of Escat and found that in children the air-pressure in inspiration is likely to exceed the pressure in expiration. His results for adults conformed to the received opinion in regard to the relative force of expiration and inspiration.

Mercier-Bellevue (2) summarizes an article in the first number of *Le Larynx*, unsigned, perhaps an editorial. The writer of the original article describes the different kinds of anosmia (mechanical, toxic, and so on) and the appropriate remedies, and makes the interesting point that lesions of the olfactory membrane are irreparable in their consequences for smell, since the filaments of the olfactory nerve do not end free but in the olfactory cells,—since in other words, the membrane itself contains the peripheral sensory ganglion of smell.

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SYNÆSTHESIA

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Though contributing little, if any, new material to aid in the understanding of synæsthesias, Marinesco (1) presents an unusually rich assemblage of facts. First, a case of colored hearing is described with particular wealth of detail. The subject is a Roumanian woman of thirty-five. It is remarked incidentally that her heredity is bad. All spoken or written words and sounds are colored, the endless variety of color and shading being the special feature of the case. The colors are always seen hovering in space; and ordinarily in the form of a strip or patch, usually brilliant, and in all grades of transparency. Sometimes the letter or word is seen dimly outlined on this colored background. The color of a word is generally determined by the colors of prominent vowels and consonants. Many details are given, and two excellent colored plates reproduce concrete instances. Reading is accompanied by very vivid auditory imagery, and the usual color experiences are evoked.

From a collection made before his death by Edouard Grüber (of Jassy) the author cites a considerable number of cases of colored hearing, schematized forms, etc. A table, representing the reports of 23 individuals, is drawn up for a comparison of the colors given the letters of the alphabet and the notes of the musical scale. The main result is to emphasize the wide range of individual variation.

Analyzing his material, the author concludes: (1) that no generalizations can be established as to sound and color correlations; (2) that the color of words is sometimes that of a prominent constituent, sometimes that produced by a mixture of the colors of the components; (3) that synæsthesias are not indicative of pathological conditions; and, finally, (4) that their existence points to an individual predisposition the main features of which are a special impressionability of the visual and the word-hearing centers, and an unusual diminution of inhibitory influences of these centers upon each other.

A condensed historical summary and a bibliography of the less commonly cited titles add to the value of the article.

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SPECIAL REVIEWS

Leçons de Philosophie. I. Psychologie. D. ROUSTAN. Paris: Librairie Ch. Delagrave, 1911. Pp. 520.

The first volume of Roustan's *Leçons de Philosophie* is devoted to psychology. The author has taken much of his material from Wundt, Ribot and James. In fact he has been greatly influenced by the latter and the book is modelled rather after the *Principles* than after more recent treatises. The emphasis is placed upon those subjects which we are accustomed to find of most interest to the French school of psychologists. Experimental psychology is practically ignored and physiology is entirely omitted. The part on sensations occupies only eighteen pages and mentions only those facts which are of the most general interest to students of the intellectual functions, such as the value of the different senses for the mental life and the possibility of improving them by education.

Throughout the book special attention is given to the important theories and the reader is guided, often with keen judgment, to a final choice. The older theories receive more attention than the modern ones, so that the book gains in historical perspective to the neglect of contemporaneous thought. With the exception of Wundt, Höffding, Bergson and other more or less important French writers, few living men are mentioned. For example under attention the only references made are to Condillac, Wundt, Höffding, Ribot, James, Bergson and Nagrac.

The volume is divided into four parts, treating respectively of general problems, which include a discussion of the purpose and limits of psychology, the subconscious, attention, personality, etc.; of the effective life, that is, pleasure and pain, the emotions, inclinations, and the passions; the intellectual life, which includes sensations, space perceptions, memory and association, generalization, judgment and language; and finally of the active life, embracing instinct, habit and will. Each chapter is preceded by a minute summary and is closed by a very incomplete bibliography.

The book is neither a text-book nor is it sufficiently up to date or inclusive to justify referring the student to it for collateral reading. The manner of treatment, however, is interesting and the style is very pleasing. One can follow the writer with profit as he illuminates

many of the theories which form the history if not always the foundation of the science.

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The Interpretation of Religious Experience. (The Gifford Lectures for 1910–12.) JOHN WATSON. Glasgow: James Maclehose and Sons, 1912. 2 Vols. Pp. xiv + 375; 328.

The title of these lectures is, I fear, misleading, for they do not deal with "religious experience" in the sense in which the layman and the contemporary psychologists use the term. Professor Watson's extensive work is an historical review of the solutions proposed by the great philosophers for the question of the ultimate nature of reality. The first volume contains a critical account of these solutions, beginning with Greek philosophy and ending with Hegel. The second volume, called constructive, deals with Faith, Knowledge and Mythology, The Fallacy of Radical Empiricism, the Realistic and the Scientific View of the World, Body and Mind, Personal and Absolute Idealism, the Problem of Evil, etc.

The more general outcome of philosophical speculation is, in Professor Watson's opinion: "No dualistic or pluralistic conception of the world, in whatever form it presents itself, can be regarded as a satisfactory solution." And the conclusion of his own investigation is "that man as a spiritual or self-conscious being is capable of experiencing God, who is the absolutely spiritual or self-conscious being, and that the influence of God upon man is not external or mechanical but spiritual, and so far from being destructive of freedom, is the condition without which freedom is inconceivable."

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DISCUSSIONS

ESTIMATION OF TEMPERATURE

To the Editor of the PSYCHOLOGICAL BULLETIN: The following observation of Mr. R. Amundsen made during his recent antarctic expedition seems to be of general psychological interest. It is found in his book *The South Pole*, Vol. I., pp. 280–282.

"On several previous sledge journeys I had made the experience that thermometers are very fragile things. It often happens that at the beginning of a journey one breaks all one's thermometers, and is left without any means of determining the temperature. If in

such circumstances one had accustomed oneself to guess the temperature, it would have given the mean temperature for the month with a fair degree of accuracy. The guesses for single days might vary somewhat from reality on one side or the other, but, as I say, one would arrive at a fair estimate of the mean temperature. With this in mind I started a guessing competition. As each man came in in the morning he gave his opinion of the temperature of the day, and this was entered in a book. At the end of the month the figures were gone through, and the one who had guessed correctly the greatest number of times won the prize. . . . Each man's entrance was awaited with excitement, and one man was not allowed to make his guess in the hearing of the next—that would undoubtedly have exercised an influence. Therefore they had to speak as they came in, one by one. . . . The monthly results were interesting. So far as I remember, the best performance the competition could show in any month was eight approximately correct guesses. A man might keep remarkably close to the actual temperature for a long time, and then suddenly one day make an error of 25°. It proved that the winner's mean temperature agreed within a few tenths of a degree with the actual mean temperature of the month, and if one took the mean of all the competitors' mean temperatures, it gave a result which, practically speaking, agreed with reality. It was especially with this object in view that this guessing was instituted. If later on we should be so unlucky as to lose all our thermometers, we should not be entirely at a loss."

In reading this one must admire the straightforward way of putting the question and solving it. It seems that our estimation of temperatures is materially different from that of time, where the mean of the estimates of even a large number of persons differs materially from reality. These results, however, were obtained from individuals who had no special training in estimating time, while Amundsen's men necessarily had great interest in the weather and acquired some practice. It would be interesting to make similar experiments on the estimation of time intervals and of distances, giving the subjects considerable practice in this work, in order to find out whether under these circumstances the mean of the estimates comes anywhere near the real value. Mr. Amundsen's experience shows clearly that such results may be of practical value.

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CHRONOSCOPE WITHOUT SPRINGS

The review of recent improvements of Psychological apparatus, published in the last BULLETIN, mentions Dunlap's attempt at doing away with the spring in the Hipp chronoscope, but fails to mention Schulze's successful solution of this problem. The chronoscope without springs and without variability of magnetic intensity, designed by Schulze and built by Zimmermann, seems to be much less known than it deserves. In the writer's opinion, who regards himself as fortunate in having a Schulze chronoscope in his laboratory, Schulze's ingenious method of utilizing, in connection with a peculiar permanent magnet, the induction currents of the make and break of a single primary current is much superior to Dunlap's method of doubling the primary current. However, no one could point out the relative advantages which either method probably possesses, as well as Professor Dunlap himself. Let us hope that he will give us the benefit of his experience in this matter.

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Hart, B. *The Psychology of Insanity.* New York: G. P. Putnam's Sons, 1912. Pp. ix + 173. $0.40 net.

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Loewenfeld, L. *Bewusstsein und psychisches Geschehen.* Wiesbaden: Bergmann, 1913. Pp. vi + 94. Mk. 2.80.

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CHRONOSCOPE WITHOUT SPRINGS

The review of recent improvements of Psychological apparatus, published in the last BULLETIN, mentions Dunlap's attempt at doing away with the spring in the Hipp chronoscope, but fails to mention Schulze's successful solution of this problem. The chronoscope without springs and without variability of magnetic intensity, designed by Schulze and built by Zimmermann, seems to be much less known than it deserves. In the writer's opinion, who regards himself as fortunate in having a Schulze chronoscope in his laboratory, Schulze's ingenious method of utilizing, in connection with a peculiar permanent magnet, the induction currents of the make and break of a single primary current is much superior to Dunlap's method of doubling the primary current. However, no one could point out the relative advantages which either method probably possesses, as well as Professor Dunlap himself. Let us hope that he will give su the benefit of his experience in this matter.

MAX MEYER
UNIVERSITY OF MISSOURI

BOOKS RECEIVED DURING JANUARY AND FEBRUARY

SCHULZE, R. *Experimental Psychology and Pedagogy.* (Trans. by R. PINTNER.) New York: Macmillan, 1912. Pp. xxiv + 364. $3.75.

BOSANQUET, B. *The Value and Destiny of the Individual.* (The Gifford Lectures for 1912.) London: Macmillan, 1913. Pp. xxxii + 331. $3.25.

WALTER, H. E. *Genetics. An Introduction to the Study of Heredity.* New York: Macmillan, 1913. Pp. xiv + 272. $1.50.

RODRÍGUEZ ETCHART, C. *La ilusión.* Buenos Aires: C. Hermanos, 1913. Pp. 253.

INGENIEROS, J. *Principios de Psicología Biológica.* Madrid: D. Jorro, Ed., 1913. Pp. 471. 6 pesetas.

RODRÍGUEZ ETCHART, C. *Psicología energética.* Buenos Aires: C. Hermanos, 1913. Pp. 94.

VINCENT, STELLA B. *The Function of the Vibrissæ in the Behavior of the White Rat.* (Behavior Monographs, I., No. 5.) New York: Holt, 1912. Pp. 81. 4 Plates.

WALLIN, J. E. W. *Experimental Studies of Mental Defectives.* (Educational Psychology Monographs, No. 7.) Baltimore: Warwick and York, 1912. Pp. vi + 153. $1.25.

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THE New York Branch of the American Psychological Association met on February 24, in conjunction with the Section of Anthropology and Psychology of the New York Academy of Sciences. The following papers were read: "Psychology As the Behaviorist Views It," Professor J. B. Watson, of Johns Hopkins University, non-resident lecturer in Columbia University; "Illusions and Hallucinations in Insanity," Mr. D. O. Lyon; "A note on the Retention of Practice," Dr. F. Lyman Wells; "Painting and the Learning Process," Mr. C. M. Sax; (1) "Methods of Orientation and Imaginary Maps" and (2) "The Probable Explanation of Certain Flock Formations of Birds," Professor C. C. Trowbridge.

ON January 27th last, Dr. James Ward, professor of mental philosophy and logic in the University of Cambridge, completed his seventieth year. In recognition of his valuable contributions to philosophy and psychology and as a manifestation of the esteem and affection in which he is held by a large circle of colleagues, past and present pupils, and other friends, his fellow-teachers in moral science in the University propose to raise a fund for the purpose of having Dr. Ward's portrait painted. It is hoped that the sum collected will be sufficient to allow of the portrait being reproduced in photogravure or by some similar process, so that each subscriber may receive a copy of the reproduction.

THE following items are taken from the press:

DR. FREDERIC LYMAN WELLS, assistant in pathological psychology at the McLean Hospital, is conducting a course of lectures and discussions on "Pathological Psychology" at Harvard University.

ON February 7, Professor Edward L. Thorndike, of Teachers College, Columbia University, delivered in the afternoon a lecture on "Social Instincts" before the department of psychology of the John Hopkins University; and in the evening he addressed the Educational Society of Baltimore on "Retardation and Elimination in High School."

DR. YUJIRO MOTORA, professor of psychology in the University of Tokyo, died on December 12. Dr. Motora took the doctor's degree in psychology about twenty-five years ago at Johns Hopkins University.